1994 VALUATION ACTUARY SYMPOSIUM PROCEEDINGS

SESSION 8

Life and Deferred Annuity Liability Models

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LIFE AND DEFERRED ANNUITY LIABILITY MODELS
Separate Account Considerations

MR. DOUGLAS C. DOLL: My comments will be general and brief. What are some considerations for modeling separate account products that are different than general account products? There are three categories of consideration:

1. The separate account values can fluctuate. A general account value will always increase at a reasonably steady rate, usually with a minimum rate of 3% or so, but the separate accounts can fluctuate greatly and even be negative.
2. There will be more than one account, and the aggregate behavior of liabilities in the various separate accounts will be different from the behavior you would project from using average separate account results.
3. There are guaranteed minimum death benefits.

Fluctuating Account Values

Warren Buffett, when asked his opinion on what the stock market would do, said it would fluctuate, and that is true. Equity and other separate accounts may have total returns that vary greatly. Fluctuating account values and the possible effects of this are something that need to be modeled. Is it acceptable to assume an average level return? For some purposes, such as pricing of the basic policy, this may suffice, if linked with sensitivity tests at high/low cumulative returns.

For other purposes, like pricing the guaranteed minimum death benefit, the fluctuations do need to be modeled, because the large values occur at the end of the probability distribution. Obviously, this then calls for a scenario generator that can generate the appropriate scenarios. It is beyond the scope of this presentation to discuss scenario generators.

Fluctuating account values may affect policyholder behavior models in ways other than simple comparisons to a "competitor index." The pattern and absolute value of returns may affect lapsation, future premiums, and transfers among accounts. Some research into the behavior of mutual funds may shed light on this.

Past fluctuations and multiple accounts mean that an in force block of business will not have a homogenous level of values -- this probably is not much different than modeling nonvariable universal life with different fund levels.

Multiple Accounts

The typical variable account will have multiple accounts, with potentially different loads and/or guarantees. The greatest differential likely will be between the general account (if there is one) versus the separate accounts; therefore, a reasonable level of sophistication for variable modeling would seem to be the ability to have a general account and one separate account. Modeling the general account portion of the variable product has all of the same considerations needed for a nonvariable product, plus the cash flows going in and out of the separate account.

Multiple accounts create additional policyholder behavior assumptions to model, namely, allocation of premiums among accounts and fund transfers among accounts. In creating an in-force model, there would be an initial allocation of premiums that presumably represents the current condition, but this would be expected to change based on relative fund performance. Similarly, fund transfers would be expected to be affected by past fund performance -- if so, then prior fund performance will need to be available at the model start date -- this may not be significant and perhaps can be modeled on a "current performance" basis. A particularly interesting assumption is, if the general account credited interest becomes uncompetitively low, whether this will precipitate a lapse or a transfer. (Of course, either one is bad for the profitability of the general account).

Obviously, the model start date values will be needed for both separate and general accounts.

For purposes of multiple accounts, it would seem reasonable to use averages of account utilization, e.g., assume all policies are 30% general account, when, in fact, individual contracts have a wide range of general account utilization.

I said that I was not going to get into statutory reserve issues, but assuming that the net statutory reserves are less than the fund value in the separate account, the model needs to reflect the fact that assets equal to fund value are held in the separate account. This is an effect that could be lost if you try to do a projection on a single account model, i.e., if the model does not explicitly allow for both general account and separate account monies. The effect can be both on expected profits (because the expected earnings rate on the separate account may be different than in the general account) and on asset/liability risks in the general account (because cash flows are impacted).

Guaranteed Minimum Death Benefits

In modeling an in-force block, the guaranteed minimum death benefit basis will need to be entered -- here is a situation where an average result may not work. Two kinds of averages will not work: (1) Using average fund performance won't work; the fluctuation in account values will have to be modeled. (2) Using average contract value may understate the cost of guaranteed minimum death benefits in an in-force model.

For example, consider two policies, each with an account value of $1,000, but one has a guaranteed minimum death benefit basis of $950 and one of $1,050. Obviously, using a basis of $1,000 (the average basis) won't work, because this would produce no current guaranteed minimum death benefit. Using an average basis of $1,025 will replicate the current guaranteed minimum death benefit, but will be incorrect if account values change. For example, if the account values each go up by $25, the model would show no guaranteed minimum death benefit, but the real world would still have a $25 guaranteed minimum death benefit on one policy.

A side issue is whether it is worthwhile to attempt to model the expected guaranteed minimum death benefit reserves through every scenario or to use an average guaranteed minimum death benefit reserve across all scenarios. In this case, I believe using the average guaranteed minimum death benefit reserve would produce a reasonable average present value. Some kind of accumulation of actual charges less actual costs also would be fairly easy to implement.

Finally, I did note that the significance and variety of guaranteed minimum death benefits have increased significantly and may be an important part of the model. These benefits can have values that vary significantly (and nonuniformly) by issue age; therefore, care should be taken on choosing model ages.

LIFE AND DEFERRED ANNUITY LIABILITY MODELS

MS. JACQULYNN S. ABDELLA: The question I'm going to address is what constitutes a good liability model. Although my comments are directed toward the modeling of universal life and deferred annuities, many of these comments are also applicable to traditional life models. I will begin with a discussion of model plan/cell selection and then cover model validation. I will finish with a universal life modeling example.

The key word in this discussion is *model.* You have a broad spectrum of choices in building your model -- from a seriatim approach to a single-cell model. Remember, you are developing a tool to analyze projected future results. The objective of this tool is to represent reality, not reproduce it.

There are tradeoffs among model size, speed and flexibility. The larger the model, the slower the run time and the more difficult it is to keep control of the process. I believe it's better to have a less complex model that adequately represents reality. This allows you more time to analyze the results of the model instead of building the model. However, some of the time saved may be lost in additional time needed to validate the simpler model. Often the small-sized models are more difficult to validate. However, the faster run time makes it easier to perform more sensitivity analyses. Surprisingly, the larger, more detailed model may not improve the accuracy of the model, as we will see in a later example. Remember the model can always be (and probably should be) refined in the future.

The purpose of the project should dictate the model complexity required. For example, will the model be used to provide comparative results or absolute results? In situations where comparative results are desired (such as determining optimal crediting strategies), tolerances for model plan representation or validation may be less stringent than cases where an absolute answer is desired (such as an actuarial appraisal). My intent is to provide some ideas to improve your liability models without compromising speed and flexibility.

Model Plan Selection and Plan Assignment

I will begin with model plan selection and plan assignment. The general idea is to select a limited number of representative plans (i.e, the model plans) and then assign the remaining plans to these model plans. To do this, start with a listing of the in-force business by plan, include policy count, units, face amount, premium, reserve, and fund value in the listing. Next, summarize the plan codes in descending order based on reserve, units, and premiums. From these summaries, select model plans that represent a fairly high percentage of the in-force reserves, units, and premiums. We typically aim to have the model plans represent 75-80% of the business before any mapping. The remaining plans are then assigned to one of the model plans. Several items (many of them interrelated) should be considered when selecting model plans and assigning plans:

- Homogeneous groups -- Groups like plans together. The plans do not need to be exactly alike to group; however, the differences should not be material. It is better to exclude the small miscellaneous plans from your model than to assign them to dissimilar plans. The latter will make validation extremely difficult. Typically, we strive to include at least 90% of the in-force business in the model after mapping. If a small percentage of plans that are excluded (say 5% of the in force) the model results can be grossed up to account for the exclusion. A gross up is appropriate if you believe profit or cash-flow patterns from the nonmodeled business will be similar to the modeled business. I would not recommend grossing up over 10%. Typically, companies have a limited number of universal life plans, which simplifies the model plan selection. Unfortunately, the same cannot be said for traditional life plans.
- Size of Blocks -- Your efforts should be concentrated on getting a good representation of the major blocks of business. Each major block of business should be represented by a model plan. Smaller blocks, if significantly different,

may require their own model plan. However, as I mentioned earlier, it may be better to exclude this business from the model and gross up the model results.

- Materiality -- Always keep the concept of materiality in mind. Additions to the model size should materially affect the results. For example, is a plan code material enough to require a separate model plan?
- Common sense -- The only thing to say here is use it!
- Subjectivity -- There is a high degree of subjectivity in building a model. If we were each given the same in-force file, I doubt that any two of us would develop an identical model. You should keep in mind that there is not one correct way to model a block of business.

Model Cell Selection

The next step (or actually a coinciding step) is the selection of model cells. This is the determination of each in-force record that will be processed. Ideally, you will want to track the variables listed below with your in-force records so that, after you assign plans, you can review the distribution of each within the model plan:

- Premium Modes -- The overall distribution of premium modes in the model should be representative of the actual in-force business. This does not mean you need a separate monthly, quarterly, semiannual, and annual cell for each plan and issue age combination. Possible alternatives include having different issue ages or risk classes, using different modes or having every xth issue date be monthly. Use whatever combination results in the correct distribution. This approach allows you to represent the premium modes without increasing the size of the model. If a premium mode is not material, do not represent it.
- Risk Classes -- Typically universal life plans have multiple risk classes (male, female, smoker, nonsmoker, preferred). Do all risk classes need to be represented in the model? That depends on the amount of business in each class and the profit patterns. If there is not a material amount of business for a given class, you may want to assign it to another class with similar profit patterns. You should recognize that, although profits will be similar, this may affect the

validation. For example, assigning the smokers to nonsmoker plans may understate both mortality and cost of insurance deductions. For the less significant classes use only one or two issue ages.

- Issue Ages -- For universal life plans (even the largest plans) I think that in most cases five ages should be adequate. Consider the distribution of issue ages. If it is fairly dispersed (especially into the older ages), you may need more ages. If it is compact, you need less ages. Do not just group decennial ages and select the middle age for the model age. Instead, you want a fairly even distribution among the model ages. However, the tail ages may have less (e.g., 5%, 30%, 30%, 30%, 5%). The issue age should represent the average age assigned not the central age. I typically weight the average by volume; however, another measure such as reserve may be appropriate. Also, consider materiality. For smaller plans, fewer ages may be appropriate. It is easy to increase the model size by using too many issue ages. For annuities, typically one average age is used. You need to consider the profit pattern by age. One average age is appropriate if the profit pattern by age is similar. However, if this is not the case (and it may not be because of higher decrements from mortality and annuitization at older ages) a couple of ages may be more appropriate.
- Issue Dates -- Often, one issue date (say July 1) per year is adequate. However, this will depend on the purpose of your model and the model start date. If you plan to show monthly or quarterly projections, using a single issue date will produce irregular results, especially if you have a significant amount of annual premium. Thus, more than one issue date may be required. I have found that, if the model date is not the beginning of the year (say October), two issue dates are required so the correct policy duration is used.

During select periods, each issue year should be modeled separately. After the select period, grouping of issue years may be appropriate.

- Band Sizes -- If significant discounts are offered to large band sizes or if mortality differs materially by band size, it may be appropriate to recognize the different band sizes. The distribution of business by band size should be considered. If the majority of business is written in a given band, only one band may be appropriate. Like premium mode, each plan, issue age, and issue date does not need to be broken down in to all band sizes.
- Funding Levels -- Universal life plans offer the policyholder great flexibility in their use of the plan -- from a term plan to an investment vehicle. The funding level affects reserves and surrender charges. Using an average fund may not appropriately represent the business. I have an example at the end that addresses this issue.

Model Validation

Model validation is one of the most important steps. I believe that often it does not receive the attention it deserves. When reviewing models for clients, the first item I typically ask for is the model validation. Unfortunately, more times than not, one does not exist. Management will be relying on the results produced by the model. Therefore, in order to place comfort in the model results, validation of the model is required. It is the old cliche: "Garbage In, Garbage Out."

Validation is defined in "Principles of Actuarial Science," found in *TSA XLIV*, as a process by which a model is checked for consistency with available information. It is a continual process. You are never finished. Over time, the model should be refined, and validation with actual results checked. If the model does not validate, appropriate refinements to the model should be made until an acceptable validation is achieved.

There are three subsets of model validation: data integrity, static validation, and dynamic validation. Data integrity relates to the underlying accuracy of the actual in-force business used to build the model, of the experience studies used as a basis for model assumptions, and of the plan descriptions used to define the products. For example, is all the in-force business included? If not, what business was left out, and why? Do reserves tie to published financial statements?

Actuarial Standard of Practice No. 23, "Data Quality," sets forth standards for actuaries regarding the selection of data, use of imperfect data, and reliance on data supplied by others. The standard states that the intended use of the data will "indicate the nature and extent of the review needed." The actuary, when selecting data, should consider the appropriateness for the intended purpose, the reasonableness and comprehensiveness of the data, and any limitations of the data. The data should be reviewed for reasonableness and consistency, even if relying on data supplied by others.

Static Validation

Static validation compares the in-force business statistics generated by the model to the actual in-force business at the model start date. It attempts to measure the accuracy of your model at the start. The comparison we typically use is the ratio of modeled in-force business to actual. The closer this ratio is to 100%, the better. The actual in-force data in this case is only for the business that is included in the model. If plan X was not modeled, do not include this plan in the actual in-force data. If plan Y was modeled with plan Z, include plan Y actuals with plan Z. You will find it easier to put together the static validation if you have tracked the necessary actual data as you build the model cells.

The items to validate on a static basis include policy count, premium, face amount, units, reserves (statutory and tax), fund value, cash value, and policy loan. The validation should be performed before and after reinsurance to verify that the reinsurance is handled correctly.

In general, the model-to-actual ratios for each of these items should be of the same magnitude and in the same direction. For example, you do not want modeled face to be 95% of actual but premium to be 107%.

Validation should be performed on a plan-by-plan basis. The validation tolerances for large model plans may be more stringent than for smaller plans. I typically review the validation on a model plan/issue age/issue year basis to be sure there are not offsetting errors. For example, you do not want Plan A to validate at 80% and Plan B at 120%, but overall it is 100%. Be aware of "modeling errors" that will only affect one year of your model. For example, typically in the year the cash-surrender value first exceeds zero, the validation is terrible because of the single issue date assumption. However, for other issues years the model validates. It is a one-year problem, so leave it as is.

The tolerances we typically use are to validate within 3% overall, 5% for large plans, and 10% for smaller plans. These may vary depending on the purpose of the model.

The real key is determining why a plan does not validate. Is it because dissimilar plans were assigned to the same model plan? Is the issue age incorrect? Or is the plan not modeled correctly? If you have used the model plan specifications (e.g., no blending of costs of insurance) and entered all assumptions (including acquisition expenses), and cell level illustrations and profit tests can be run to verify the underlying model plans are working correctly, then your problem is probably with plan assignments. Once you have determined the why, appropriate model refinements can be made and the validation rechecked.

I have one additional comment on premiums. For flexible premium products, what is the actual premium? Is it target, billed, or something else? This premium may not be consistent with the premium in the model since the model premium should reflect premium persistency. Therefore, static validation of premium may not be possible.

The static validation of fund value may also not be possible unless you have entered historic credited rates and premium payment patterns into the system. Often the initial fund value is an entered item in the model, and therefore should automatically validate.

If particular items in the model do not validate, you may be tempted to gross up those items. I would not recommend this approach if the validation varies in magnitude for various items. For example, if premium is off 5% and face amount is off 10%, do not gross up premium 5% and face amount 10%. The different magnitude of the validation may indicate that something in the model is not represented correctly. You really need to determine why the model does not validate before applying gross-up factors.

Dynamic Validation

Dynamic validation compares modeled results to actual results for prior periods. Historical data for two to three years are needed, preferably by line of business. Here are a couple of ways a dynamic validation can be done:

1. Project the first year of the model, and compare trends in the model results to historical amounts. For example, if your model start date is January 1994, compare the model projected results for 1994 to actual results for 1991, 1992, and 1993. If you model is an in-force model, you will need to compare renewal amounts.
2. Develop a model with in-force data from a prior year-end, say 1992 year-end. Project 1993 including current-year sales. The results are compared to actual 1993 results.

Here again the key is to explain why items do not validate and make appropriate refinements to the model. Be sure that actuals are adjusted for known differences from the model (e.g., nonmodeled business, one-time expense, or financial reinsurance not modeled). The items to consider are:

- Premium -- Ideally you want actual premium by product split between first year and renewal. Dynamic validation provides a means to check the validity of the premium persistency assumption. How do you develop the premium persistency assumption? I have a couple of ideas. First, enter into the model what you believe to be a reasonable assumption. Compare actual to projected. Gross the premium-persistency factors up or down uniformly to validate premiums.

Second, develop an annual premium-persistency assumption based on historical data. Start with in-force premiums from, say, five years ago, and first-year premiums for each year thereafter. Using the lapse assumption from the model, project premiums forward. Solve for the premium-persistency assumption that replicates in-force premium at the model start date.

- Investment Income -- Compare model and actual investment yield. Actual investment income should be adjusted to exclude items not in the model, like investment income on free surplus or nonmodeled reserves.
- Claims -- Do death benefits trend well? Be aware of historical years when claims were high or low relative to the average. Model results should trend to the average if the mortality assumption is reasonable. It is often easier to see trends by comparing death benefits per $1,000 in force instead of dollar amounts, especially if the in-force business is growing or declining.
- Lapses and Surrender Charges -- Ideally you would like to compare lapses (no cash value) and surrenders (with cash value). Be sure you understand what the model value includes (e.g., does it include maturities?). If surrenders do not validate, it may be a problem of using an average fund instead of a problem with the lapse assumption, especially if the cash values did not validate. I will address this in an example later.
- Expenses -- Actual expenses will need to be split between acquisition and maintenance. Are all expenses included in the model? For example, are pricing assumptions used in the model or was corporate overhead included? If not, an adjustment for excess expenses may be required.
- Commissions -- Actual commission should be split between first year and renewal. Compare actual commission percentages to those produced by the model. Comparing percentages adjusts for any premium differences.
- Taxes -- Do actual and projected taxes compare? Consider both tax rate and taxable income. There may be adjustments to taxable income that are not included in the model. It may be helpful to compare the components of taxable income (e.g., statutory income, adjustment for tax reserves versus statutory

reserves, and additional taxable income associated with the deferred acquisition cost proxy tax).

- Changes in Reserve/Policy Loan -- These items should be reviewed for reasonableness compared to historical. If the validation is poor, is it because of incorrect decrements or reserve calculations?
- Reinsurance Costs -- Consider the pieces that make up the reinsurance cost (i.e., ceded premium, expense allowances, reserve credits, claim reimbursements). Do each of these items validate? Is reinsurance modeled correctly?
- Components of Fund Value -- Compare projected policy loads, cost of insurance charges, and so on, to actual. The comparisons are most easily made on a unit basis. For example, compare cost of insurance per $1,000 net amount at risk and policy loads as a percent of premium or per policy.

Universal Life Modeling Example

Next I would like to go over a universal life modeling example. The example is based on the block of in-force policies shown on Table 1. The product characteristics are summarized as follows:

- Back-loaded universal life
- Sold 1990 through 1993
- Five-year minimum premium guarantee
- Universal life commissioners reserve valuation method reserves
- Four underwriting classes: male/female, smoker/nonsmoker

For our first attempt at modeling the business, we took a simplified approach (Table 2). All business was modeled as male nonsmoker and grouped into three issue ages. Each issue year was modeled, so in total there were 12 model cells. Chart 1 shows the static validation of our first attempt. It was not very good (74% on reserves and 70% on cash values).

TABLE 1

Modeling Universal Life -- An Example

In-Force Statistics as of December 31, 1993

Number of Policies	10,800
Average Volume	$100,000
Fund Value	$47.1 million
Statutory Reserve	$26.1 million
Cash Value	$17.2 million

TABLE 2

Simple

Plans	1
Ages	3
Years	4
Cells	12

So we try again. Since simple did not work, we decided to model everything (Table 3). We modeled male nonsmokers, male smokers, female nonsmokers, and female smokers using nine issue ages for each plan. Again, all issue years were modeled. We now have 144 model cells (12 times the size of our simple approach).

TABLE 3

Second Attempt -- We Need More!

	Simple	More!
Plans	1	4
Ages	3	9
Years	4	4
Cells	12	144

CHART 1

Validation of First Attempt

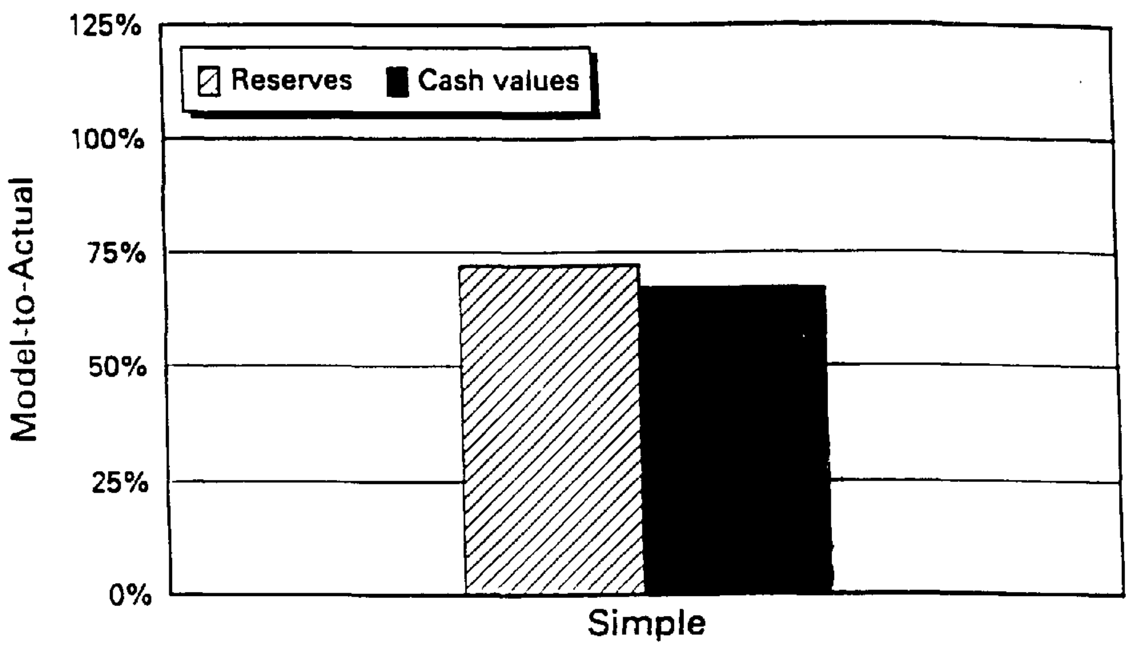


Chart 2 shows the validation of the second attempt is only slightly better than the first (76% on reserve and 75% on cash value). The larger model did not improve the results. We sat back and contemplated what might affect the model that was not recognized by plan differentiation or issue age. We decided to look at the effect of funding levels.

The funding level affects:

1. Universal life commissioners reserve valuation method reserves -- In particular the r factor is the ratio of the actual fund value to the guaranteed maturity fund. Since r is capped at 100%, using a ratio based on the average fund for all policies may not produce the actual reserve.
2. Cash values -- The funding level affects cash values since 100% of the surrender charge may not be available on minimally funded policies.
3. Premium assumptions -- Different funding levels will have different premium payment patterns, which range from a term level premium to fully funded premium to dump-in premiums. Premium persistency may also vary by funding level.
4. Future earnings -- As a result of a combination of the above items, future earnings may differ by funding level.

The next step was to segment the business by funding level. Here are some ways this can be accomplished:

1. Separate the policies between those with cash value and those without cash value. This is the simplest approach and the one taken in Table 4.
2. Develop target fund levels based on different premium assumptions (e.g., pay target premium), and separate the policies based on targeted funds. The premium assumptions can be based on your knowledge of how the business is sold.
3. Separate the policies based on the guaranteed maturity fund(i.e., greater than and less than the guaranteed maturity fund). This recognizes the differences in the r factor.

CHART 2

Validation of Second Attempt

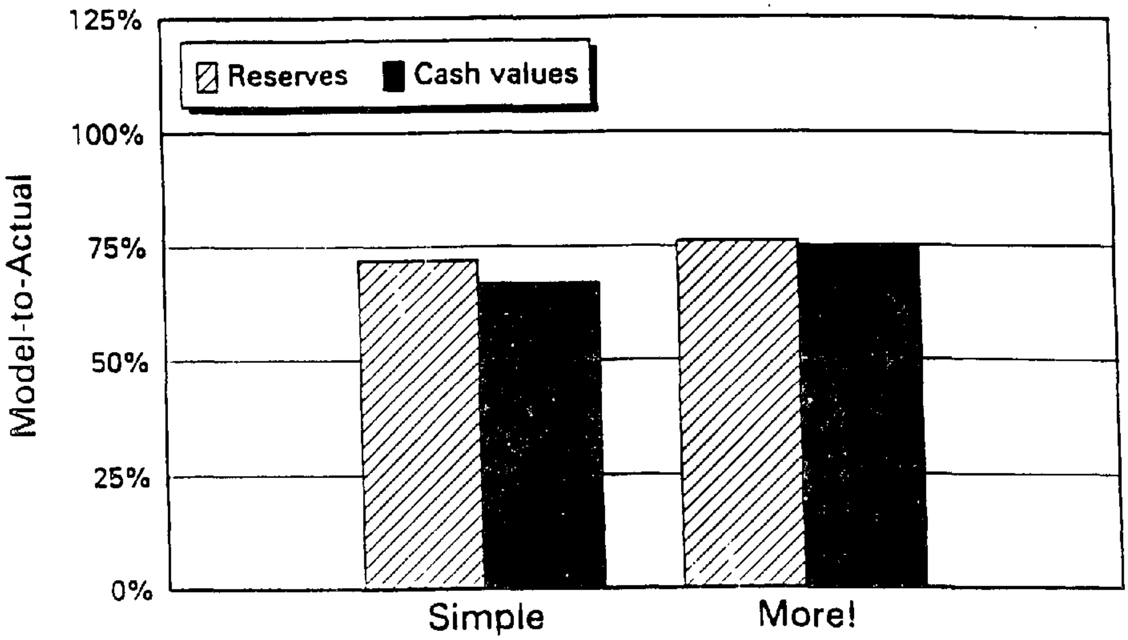


TABLE 4

**Segmentation by Funding Level
($ millions)**

	Fully Funded	Lightly Funded	Total
Fund value	$36.2	$10.9	$47.1
Statutory reserve	23.7	2.4	26.1
Surrender charge	19.0	17.5	36.5
Cash value	17.2	0.0	17.2

Next we developed premium assumptions appropriate for each funding level as shown in Table 5. These assumptions will depend on how you have split the business. In this case we have assumed that the lower funded plans are functioning as term plans and have assumed lower premiums and premium persistency. The fully funded plans assume dump-ins and higher premium payment and premium persistency.

TABLE 5

Premium Assumption by Funding Level

	Fully Funded	Lightly Funded
Dump-in premium	Yes	No
Premium pattern	Higher	Lower
Premium persistency	Higher	Lower

For the third modeling attempt, we have modeled male nonsmokers, male smokers, and female nonsmokers (Table 6). The female smokers were not significant enough to model separately. We went back to three ages, added the two funding levels, and continued to model each issue year. We now have 72 model cells (half of the large model, yet six times the simple model).

TABLE 6

Third Attempt -- We Need a Better Model

	Simple	More!	Better
Plans	1	4	3
Ages	3	9	3
Funding Levels	-	-	2
Years	4	4	4
Cells	12	144	72

Chart 3 shows the validation is now acceptable. Reserves are at 99.5% and cash values at 101.5%. We now have a better model.

Chart 4 compares the projected earnings from each of the three models. As you can see they are very different initially. I would tend to believe the "better" model provides a better representation of actual, but only time will tell.

CHART 3

Validation of Third Attempt

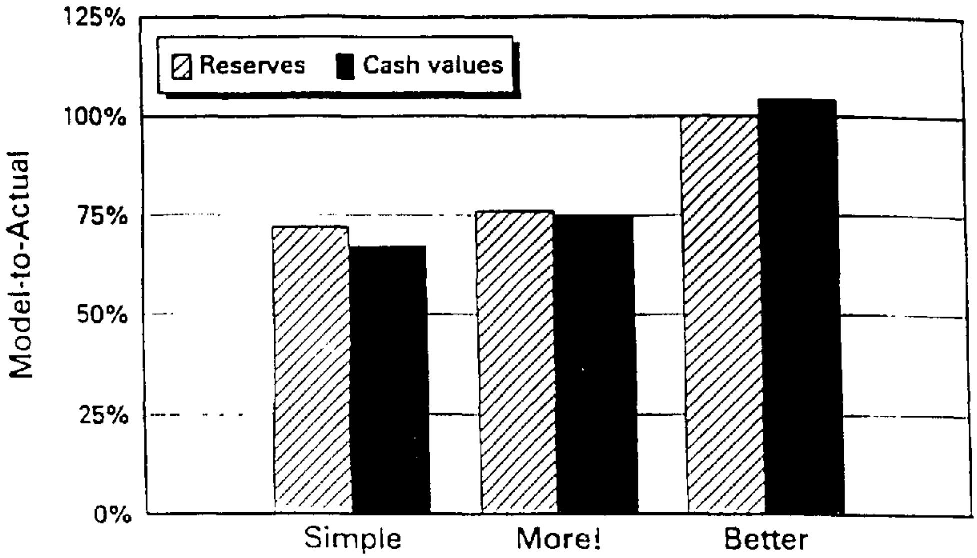
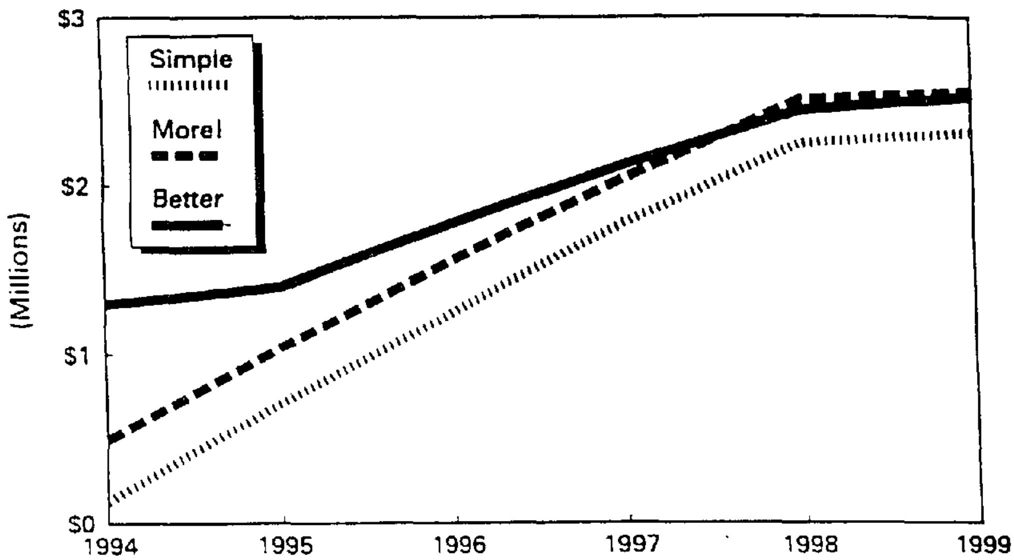


CHART 4

Comparison of Projected Statutory Earnings



LIFE AND DEFERRED ANNUITY LIABILITY MODELS

MR. C. PHIL ELAM: This topic has been a subject of interest to me for several years. One of the reasons it is interesting is that it has so many important applications. It certainly has application to cash-flow testing, but also to pricing, product design, and asset/liability management.

However, I sense that too often cash-flow-testing areas find themselves developing the behavior models from scratch. I think that's unfortunate. This work needs to begin much earlier in the pricing and product design processes. But we have to start somewhere, and I sense that we're making good progress.

I'll start with a road map of what I will cover. I'm going to talk about dynamic behavior models. I will divide them into two categories: policyholder behavior and company behavior. I'll make some general observations on surrenders/withdrawals, policy loan utilization, and flexible premium payments. Then I'll give an example using a single premium deferred annuity (SPDA).

Next, I'll talk about company behavior. Here I will limit my comments to crediting rate strategies. I will make some observations and present another example using the SPDA product.

Policyholder Behavior Models

Surrender/Withdrawal Behavior -- In designing a behavior model, one should start by looking at the product features involved. Surrender/withdrawal models are needed for many products. Traditional life products provide policyholders with a cash surrender value, which they can receive upon terminating the policy. Nontraditional life insurance and annuity products offer both full surrender and partial withdrawal features.

However, nontraditional products typically impose a declining scale of surrender charges on early surrenders. For nontraditional life products, the surrender charge schedule may run 15-20 years, declining over that period. For deferred annuities, the period may run five to ten years.

In addition, products may offer special free partial withdrawal provisions, which permit a limited amount of the funds to be withdrawn without penalty. For instance, deferred annuities commonly offer a 10% free partial withdrawal provision. Under this provision, the policyholder can withdraw up to 10% of the account value each year without surrender charges.

After reviewing the product features, one should consider the decision process of the policyholders. Why will they exercise these options? The reasons would include unexpected expenditures or emergencies that necessitate drawing upon their funds. The reasons would also include planned expenditures, such as college education, that were anticipated when they purchased the contract. Finally, as policyholders reach retirement, they may begin drawing on their policy values to supplement their income. For example, policyholders may use systematic withdrawals to produce a monthly income.

I would characterize the above reasons as noneconomic decisions, in the sense that they have little to do with the market interest rate environment. In addition to these noneconomic reasons, some policyholders will exercise their surrender/withdrawal options to realize an economic gain. Such gains may be possible when market interest rates rise above their policy's crediting rate. Consequently, one should consider the degree to which policyholders will be motivated by potential gains from withdrawing funds and reinvesting in higher yielding alternatives.

These incentives are tempered by several factors. As I mentioned earlier, withdrawals often are subject to surrender charges. These charges represent a cost to the policyholders for exercising their surrender/withdrawal options. Depending on the product, type of business, and attained age of the policyholder, there may also be adverse tax consequences for early withdrawals.

For life insurance products, the insured's health may have deteriorated after the original policy was issued. To preserve the insurance protection, the policyholder would need to purchase a new policy. But, it may be difficult to obtain new life insurance coverage if the insured's health has declined. Even if the insured's health has not declined, the insured may be reluctant to go through the underwriting process again.

After considering the surrender/withdrawal features and policyholder reasons for exercising the options, one will likely conclude that the policyholder behavior model should capture noneconomic decisions. These decisions will lead to withdrawal activity even when a policy's crediting rate compares favorably with alternative rates in the market.

The model should also capture economic decisions. These decisions will lead to increased withdrawal activity when policyholders can realize a financial gain by exercising their options. But, the model must recognize the cost of exercising those options. The costs include surrender charges, any adverse tax consequences, and for life insurance, the implications of changes in health.

<u>Policy Loan Behavior</u> -- A policy loan basically allows access to a policy's cash value without requiring the policyholder to surrender the contract. The cash value and death benefit provide collateral for the loan.

As with other loans, a policy loan accrues interest. Older contracts typically have the loan interest rate fixed by the terms of the contract, with the rate ranging from 6 to 8%. Many newer contracts have moved to a variable loan interest rate provision. Under a variable rate provision, the loan interest rate follows a current corporate bond index. This insures that the loan interest rate will bear a reasonable relationship with current market interest rates.

Although the loan interest rate is an important factor, it does not provide the full story on the cost of a policy loan. To understand the full loan cost, one must also consider how the presence of a loan affects the interest credited to the policy value. Nontraditional products apply the stated crediting rate to the portion of the policy value that is not borrowed. However, a separate rate is often applied to the amount of the policy value backing the policy loan.

Typically, the rate credited to the borrowed amounts equals the loan interest rate less a spread of 1-2%. For example, if the loan interest rate is 6%, a policy might credit 4% on borrowed amounts. Hence, the policy loan would have a 2% net cost.

The above approach passes the cost of policy loans directly to the policyholders making the loans. In contrast, many traditional life products use an indirect recognition method. Under the indirect approach, the effect of policy loans is pooled across a class of policyholders. The policy loan interest rate affects the dividend crediting rate. However, the effect of policy loans is spread across all policyholders, both those who have loans and those who do not.

Finally, some nontraditional policies contain a preferred loan provision. Under this provision, a small amount of the account value can be borrowed at a very low (perhaps even zero) net cost. For example, a policy might provide that up to 10% of the account value can be borrowed at a zero net cost. The policy loan might accrue interest at a 6% rate. But, the portion of the policy value backing the loan would be credited with 6% interest. Policy loan amounts in excess of the 10% limit would carry the usual net cost, such as a 6% loan interest rate and a 4% crediting rate.

Policy loan and surrender models have many similarities. The reasons for making policy loans include unexpected expenditures, planned expenditures, and economic gains. In developing the behavior assumptions, one should consider the effect on the policy's crediting rate, as well as any tax consequences. If a life insurance policy avoids modified endowment contract status, the tax situation may be very favorable. Unlike a full surrender, a policy loan still continues the life insurance protection on the insured.

As with the surrender model, the loan utilization model should capture both noneconomic and economic decisions. Due to noneconomic decisions, one would expect a certain amount of loan activity even when the crediting rate is higher than market interest rates. Due to economic decisions, one would expect increased loan activity when the policy's crediting rate is lower than market interest rates.

One should also consider the effect of marketing strategies and sales illustrations. If the marketing approach focuses heavily on a preferred loan privilege, one should expect a higher utilization of that feature.

Flexible Premium Behavior

Nontraditional products also provide options for paying premiums. These products typically provide flexibility both in the amount and timing of premium payments. Policyholders have the right to deposit additional premiums, as well as defer regularly scheduled premiums.

In developing a premium payment model, one should consider how the rate guarantees on new premiums are set. For practical reasons, the company might reset the crediting rate applicable to new premiums monthly or quarterly. Hence, if market interest rates suddenly drop, policyholders may still be able to deposit funds and receive a very attractive rate guarantee.

For this reason, the premium payment behavior model should recognize the potential for antiselection when current crediting rate guarantees on new premiums lag market interest rate changes.

SPDA Example -- The SPDA product provides a simple example. It has no policy loan feature and only one premium. Thus, the policyholder models consist only of surrender/withdrawal behavior. In developing assumptions for a specific product, one should consider a number of factors, including the product features, the marketing strategy, the average premium amount, and past experience.

One should also consider expected experience trends. I think it's safe to say that over time policyholders will become smarter and make more economic-based decisions. Therefore, we should expect a greater percentage of policyholders to surrender their contracts when they can realize financial gains. Such trends have important implications for insurers, in that the cost of the embedded options will likely increase over time.

Most actuaries have worked with what I would call a static surrender model. Take for example a hypothetical SPDA with a surrender charge schedule that starts at 7% and declines 1% a year. One might construct expected surrender rates that start out very low, remain low over the surrender charge period, spike up when the surrender charge expires, and then drop to an ultimate level (see Table 1).

I think it's misleading to describe these surrender rates as expected surrender rates. I think such rates are better described as expected surrender rates in a world where interest rates remain constant. If interest rates change and competitors' new money crediting rates rise above the policy's crediting rate, one would expect higher surrender rates. And if competitors' new money crediting rates fall below the policy's crediting rate, one would probably expect slightly lower surrender rates.

These observations suggest a two-dimensional table as shown in Table 2. Note that the central column (identified by the zero interest rate differential) reproduces the original, static assumptions. As one moves to the right of the central column, the rate differential represents the excess of the competitor's new money rate and the policy's crediting rate.

TABLE 1

Static Surrender Assumptions

Policy Year	Surrender Charge	Expected Surrender Rate
1	7%	4%
2	6	5
3	5	6
4	4	6
5	3	6
6	2	6
7	1	6
8	0	15
9	0	8
10+	0	8

As this differential increases, higher surrenders are expected. This is especially true as the surrender charge declines.

As one moves to the left of the central column, the negative rate differential indicates that the policy's crediting rate is higher than the competitor's new money rate. This situation might occur when market interest rates fall, and the policy's crediting rate lags those changes. Consequently, policyholders have a very attractive rate.

TABLE 2

Dynamic Surrender Assumptions

Policy Year	Surrender Charge	Interest Rate Differential						
		-3%	-2%	-1%	0%	+1%	+2%	+3%
1	7%	4%	4%	4%	4%	5%	5%	8%
2	6	5	5	5	5	6	7	11
3	5	5	5	5	6	6	7	13
4	4	5	5	6	6	6	9	15
5	3	5	5	6	6	7	11	16
6	2	5	5	6	6	7	13	16
7	1	5	6	6	6	9	15	16
8	0	14	14	14	15	20	24	25
9	0	7	7	7	8	13	17	18
10+	0	7	7	7	8	13	17	18

This pattern of surrender assumptions can be achieved with an arctangent function:

$$SW_t = a_t + b \, x \text{ ARCTAN } [m \, x \, (CR_t - PR_t - AS_t) - n]$$

Where:

SW_t = Annual surrender rate at time t;
CR_t = Competitor's new money rate at time t;
PR_t = Policy's crediting rate at time t;
AS_t = Amortized surrender charge at time t.

By adjusting the parameters, one can achieve the desired pattern. I should explain the amortized surrender charge component of the function. Basically, the amortized surrender charge reduces the effective gain in crediting rate by the cost of exercising this option.

For example, suppose that a policy has a 6% surrender charge. Suppose also that the policyholder will expect to recover the surrender charge over a three-year horizon. Therefore, a policyholder will need approximately a 2% higher rate just to break even on the exchange. Anything over a 2% differential will provide an incentive to move to the competitor's new policy.

Company Behavior Models

Crediting Rate Strategies -- Moving to company behavior and crediting rate strategies, I would begin with some general observations. I think many product managers think in terms of having product specific investment and reinvestment strategies. Then, they link their crediting rates to the asset yields produced by those strategies, less a required interest margin.

Under this investment strategy approach, asset book yields gradually increase when market interest rates rise. On the other hand, asset book yields gradually decrease when market interest rates fall. In general, the asset book yields and related renewal crediting rates lag market interest rate changes.

At this point, I would divide the crediting rate models into two types: implicit and explicit. Under an implicit strategy, one simulates investment and reinvestment strategies, and backs into the implied crediting rates using the required interest margin.

However, I want to focus on the explicit type. With an explicit strategy, one models future crediting rates as a function of the current crediting rate and future market interest rates.

Take for example an SPDA with an initial crediting rate equal to the current five-year Treasury rate, less 75 basis points. Assume that the crediting rate will reset annually, following that same index (i.e., the five-year Treasury less 75 basis points).

At the point of reset, the crediting rate will move partially toward the index. If the index goes up, the crediting rate will reset partially toward that higher rate. If the index goes down, the crediting rate will reset partially toward that lower rate.

Finally, assume that the contract guarantees that the crediting rate will never be less than 3%.

Rather than experimenting with different investment strategies and backing into the crediting rates, one can define the crediting rates directly with a formula:

$$PR_t = \max\{3\%, PR_{t-1} + [RS \times (MR_t - PR_{t-1})]\},$$

Where:

PR_t	=	Policy's crediting rate at time t;
RS	=	Crediting rate reset speed;
MR_t	=	5-year Treasury rate at time t less 75 basis points

Under this approach, one can develop a strategy that responds appropriately to market interest rate changes (see Table 3). Note that the resulting crediting rates lag market interest changes much like we described earlier for the implicit approach.

TABLE 3

Illustrated Crediting Rates for 25% Reset Speed

t	MR_t	PR_{t-1}	Rate Difference	Rate Change	PR_t
0	10%	-	-	-	10%
1	6	10%	(4%)	(1%)	9
2	5	9	(4)	(1)	8
3	6	8	(2)	(0.5)	7.5
4	9.5	7.5	2	0.5	8

The explicit approach provides a very practical way to analyze different crediting rate strategies. One can project the liabilities without modeling investment yields separately for each crediting rate class of funds. The reference rate and reset speed provide considerable flexibility. One can describe how crediting rates will behave under different interest rate scenarios. This is particularly useful in the product design and pricing processes.